

## A MIST-SPRAYING APPARATUS

The present invention relates to a mist-spraying apparatus primarily but not exclusively for use in an enclosed space.

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The aim of the invention is to provide a 'dry' mist which can sanitize exposed surfaces within an enclosed space without wetting them. The applications of such an apparatus are varied but the present invention has been designed primarily for use in the sanitization of exposed surfaces within  
10 an enclosed space that may be a storage area, a room or the like. For example, such a space may comprise the interior of goods and delivery vehicles, typically those which are used to transport items such as hospital laundry and the like. When such laundry is transported it is common for the same vehicle to be used to pick up dirty laundry at the same time as  
15 delivering clean laundry. In such circumstances, the opportunity for cross-contamination to occur is great. Even when dirty laundry is not housed within the same vehicle interior as clean laundry, the same vehicle is often used to transport both at separate times so that it is still advantageous for a means to be provided that can sanitize the interior of the vehicle between  
20 trips.

Similar requirements exist in other fields. For example, operating theatres are in constant use and whilst new sterile packs of instruments and linen are used for each patient, the surfaces within the theatre itself are not  
25 normally sanitized between operations. As many operations cause spillage of blood and other body fluids, the sanitization of exposed surfaces within the theatre between operations would be highly desirable.

Commercial glasshouses and battery hen-houses and the like also  
30 need to be sanitized regularly and mist-spraying apparatus is often used to spray biocides of various kinds within these structures.

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In all of these applications it is a desirable requirement that the mist being sprayed reaches all parts of the enclosed space so that every exposed surface within the space can be treated.

5 It is therefore an object of the present invention to provide a mist spraying apparatus that can be used for sanitizing an enclosed space and that will substantially fulfill the aforesaid requirement.

According to the present invention there is provided a mist spraying  
10 apparatus primarily but not exclusively for use in an enclosed space comprising

an air-blowing means with an outlet conduit through which air can be blown into the space and an inlet conduit through which air from within the space can be drawn for blowing through the outlet conduit to circulate within  
15 the space;

a spraying means comprising a pump for delivering liquid from a reservoir to an atomizing nozzle for spraying the liquid into the space in the form of an atomized mist, the atomizing nozzle being located within the outlet conduit so that atomized particles emitted by the atomizing nozzle are  
20 entrained in the airstream emitted by the air-blowing means and thereby distributed evenly throughout the space; and

a control means for controlling operation of the air-blowing means and the spraying means that is adapted to commence operation of the air-blowing means prior to operation of the atomizing nozzle and to continue  
25 operation of the air-blowing means after operation of the nozzle has ceased in order to continue circulation of the air and any atomized particles entrained therein around the space for a predetermined period of time.

Hence, in the present invention the air-blowing means is used to  
30 create an airstream in the space which immediately entrains the atomized particles being emitted by the atomizing nozzle. As a result the particles are rapidly diluted but also evenly distributed into the airstream and are thus applied evenly over all exposed surfaces within the space being sprayed.

Circulation of the air before the atomizing nozzle's operation ensures that the particles emitted by the nozzle are always entrained as atomized particles and do not clump together to form droplets, which are wetting and tend to fall uselessly to the floor of the space. Likewise, recirculation of the air after  
5 operation of the nozzle has ceased ensures that all surfaces within the space are reached by the airstream. It will be appreciated that the length of time that the nozzle operates and that the air is recirculated after nozzle operation has ceased will depend on the nature and concentration of the liquid being sprayed, the size of the enclosed space and the particular application of the  
10 apparatus and can be varied as required.

Preferably, the atomizing nozzle is located centrally within the outlet conduit.

15 Preferably also, the outlet conduit has a rectangular cross-sectional profile.

Preferably also, the outlet conduit defines a slot so that the airstream emitted into the space is in the form of a slot-jet.

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Preferably also, the atomizing nozzle is inset within the outlet conduit.

Preferably also, the spraying tip of the nozzle is inset by at least 25 mm and by no more than 40 mm into the outlet conduit.

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Preferably also, the air-blowing means is provided with a source of steam whereby steam is additionally blown into the enclosed space through the outlet conduit.

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Preferably also, the atomizing nozzle comprises a 60° solid cone nozzle.

Preferably also, the spraying means is adapted is adapted to spray at least 11 litres of liquid per hour at a pressure of  $7 \times 10^5$  N per  $m^2$  (7 bar).

Preferably also, the air-blowing means comprises a cylindrical fan.

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Preferably also, the apparatus is located in proximity to the ceiling at the top of a wall of the enclosed space.

The present invention will now be described by way of example with  
10 reference to the accompanying drawings, in which:-

Fig. 1 is a schematic diagram of a mist-spraying apparatus according to the present invention; and

15 Fig. 2 is a perspective view of the exterior of apparatus as shown in Fig. 1 when mounted within the storage area of a delivery vehicle.

A mist-spraying apparatus in accordance with the invention comprises an air-blowing means 1 and a spraying means 2. Preferably, as  
20 shown in Fig. 2 the apparatus is adapted to be located within a housing 3 that can be mounted at a suitable site within an enclosed area, as partially shown in Fig. 2 and as further described below, and connected to a power source. Apparatus that is intended to be used within a vehicle can be adapted to be powered by the vehicle itself by being linked to the vehicle's batteries.  
25 Alternatively, it can be provided with its own battery power supply which is adapted to be re-charged when the vehicle is in motion. Alternatively, apparatus for use in buildings and other permanent or semi-permanent structures can be powered from a mains electricity supply.

30 With particular reference to Fig. 1, the air blowing means 1 comprises a fan 4 powered by a motor 5 and defines an outlet conduit 6 through which air can be blown into the space and an inlet conduit 7 covered by a grille through which air from within the space can be drawn for blowing through

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the outlet conduit 6 to circulate within the space. The fan 4 is preferably a cylindrical fan but any suitable blowing means can be employed. For example, a cylindrical fan which is 130 mm across is capable of delivering an airflow of between 1.4 and 1.7 m<sup>3</sup> per minute, which is suitable for use in an average-sized vehicle storage space with approximate dimensions of 12m by 3m by 3m (40' x 10' x 10').

The outlet conduit 6 is located at the front of the housing 3 and it has been found that an outlet conduit 6 with a rectangular cross-sectional profile provides an airflow pattern that is better at reaching all corners and exposed surfaces within spaces which are rectangular, parallelepipedal spaces than the airflow pattern provided by a circular outlet conduit. The outlet conduit 6 therefore defines a slot 8 so that the airstream emitted into the space is in the form of a slot-jet. The slot 8 preferably has dimensions of 85 mm by 70 mm when used to deliver an airflow as detailed above within the storage area of a delivery vehicle which is long and narrow, as shown in Fig. 2. In this case the slot 8 is orientated with its longer sides vertical but these sides can be disposed horizontally for enclosed spaces which are wider than they are high. Also, the apparatus is preferably located in proximity to the ceiling at the top of a wall of the enclosed space, as shown in Fig. 2. This enables the apparatus to mist-spray the space effectively.

The spraying means 2 comprises a pump 9 for delivering liquid from a reservoir 10 to an atomizing nozzle 11 for spraying the liquid into the space in the form of an atomized mist. The atomizing nozzle 11 is located within the outlet conduit 6 so that atomized particles emitted by the atomizing nozzle are entrained in the airstream emitted by the fan 4 and thereby distributed evenly throughout the space. In order to obtain the most efficient dispersal of the atomized particles within the airstream, the atomizing nozzle 11 is located centrally within the outlet conduit 6 and preferably its spraying tip 12 is inset therein. It has been found that the spraying tip 12 should be inset by a distance  $l$  at least 25 mm but no more than 40 mm into the outlet conduit 6 to ensure that the atomized particles emitted therefrom are all entrained in



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the most efficient manner in the airstream. Also, the atomizing nozzle 11 preferably comprises a 60° solid cone nozzle. Typically, such a spraying means should be capable of spraying at least 11 litres of liquid per hour at a pressure of  $7 \times 10^5$  N per m<sup>2</sup> (7 bar). Such a spraying rate is suitable for use in  
5 a vehicle storage space as detailed above.

A control means 13 is provided for controlling operation of the air-blowing means 1 and the spraying means 2 and is adapted to commence operation of the fan 4 prior to operation of the atomizing nozzle 11 and to  
10 continue operation of the fan 4 after operation of the nozzle 11 has ceased. This continues circulation of the air and any atomized particles entrained therein around the space for a predetermined period of time, which may be several minutes, dependent on the size of the enclosed space being treated.

15 This arrangement has two advantages. First, when an atomizing nozzle is operated, the pump 9 switches on and during an very short initial period the pressure of the liquid being discharged by the nozzle 11 rises to a predetermined substantially constant level. During the period of time wherein the pressure is rising, the nozzle 11 tends to discharge liquid  
20 particles that are not fully atomized. However, these particles can be broken up and entrained fully into the airstream flowing past the nozzle 11 if the airstream has been established prior to operation of the nozzle. Likewise, when the pump 9 is switched off, the nozzle 11 tends to discharge liquid particles but again these can be broken up and entrained within the  
25 airstream if the airstream is continued at a constant level for a predetermined time thereafter.

Second, continuing to recirculate the air along with entrained particles within the space for a predetermined period even after the nozzle 11  
30 has ceased operation, ensures that all exposed surfaces within the space are reached by the airstream and can be acted upon by the sprayed liquid.

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The control means 13 is provided with an emergency stop button 14, for use in the unfortunate event that the apparatus is remotely operated whilst a person is trapped within the space. To reduce the chances of such an occurrence, the control means 13 is preferably provided with an audible  
5 alarm 15 which sounds continuously during operation of the apparatus. In addition, the control means 13 can be linked to locks on the doors of the space to prevent them being opened whilst the apparatus is in use.

In order to ensure that the reservoir 10 is always adequately filled  
10 with liquid to be sprayed, a float 16 is provided within the reservoir 10 and used to trigger an alarm by making electrical contact with, for example, a block 17 located at the base of the reservoir 10 and linked to the control means. When the level of the liquid in the reservoir becomes low, a flashing light, for example, or other alarm means can be triggered by the control  
15 means 13 to warn operatives that the reservoir 10 should be topped up.

The control means 13 can also incorporate or be linked to a recording means 18 which records the time and duration of each operation of the apparatus so that checks can be run to ensure that operatives are using the  
20 apparatus appropriately and adequately.

It will be appreciated that the apparatus as described herein can be readily adapted for use in various applications. The liquid being sprayed can also vary as required. For example, when spraying soiled laundry, the liquid  
25 can comprise a sanitizing liquid including biocides and disinfectants. Alternatively, if used for mist-spraying in glasshouses, the liquid may comprise a pesticide, fungicide, and/or a foliar feed. Preferably, however, the liquid being sprayed comprises a mixture of an oil and aqueous solution. Such a solution produces a more finely atomized spray than an aqueous  
30 solution alone. Hence, an oil, for example in the form of a monopropylene glycol or monoethylene glycol, should be added to the liquid advantageously in a quantity of less than 1 part oil to every 100 parts aqueous solution by volume.

In a modification of the above apparatus for particular use in a hospital operating theatre or an enclosed space wherein it is desired not only to sanitize exposed surfaces but also to treat air-borne particles, the air-  
5 blowing means 1 can be supplied with steam from a suitable source so that steam is additionally blown into the enclosed space. Other gaseous substances could also be supplied to the apparatus for spraying into the enclosed space along with or in place of the steam as appropriate for any particular use of the apparatus.